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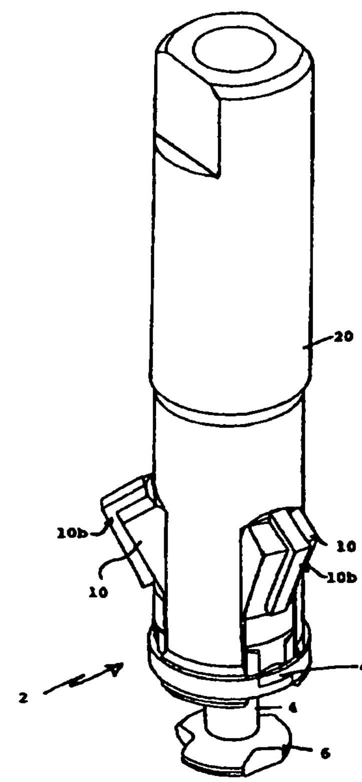
(57) Abstract

A drill for forming an undercut in the base part of a hole drilled into masonry comprises a drive shaft (20) and a cutter assembly (2) coupled to a distal end of the drive shaft. The cutter assembly comprises a support structure (4) and an array of cutters (10) mounted on the support structure for pivotal movement between a retracted position in which the cutter assembly can move along the preformed hole into the base of the hole and a radially-expanded position in which the cutters form a generally conical undercut in the base of the hole upon rotation of the drive shaft with the conical undercut widening in cross section in a direction towards the outer end of the hole.



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UNDERCUTTING DRILLS

The present invention relates to drills and more particularly to a drill for producing an undercut in a hole drilled into masonry in order to receive a masonry anchor of undercut type.

Undercut masonry anchors are often used in anchoring situations where the anchor is likely to be subjected to high stress and failure could be critical. Undercut masonry anchors operate by being set into an undercut or enlargement formed within the base part of a hole drilled into concrete or other masonry. As an example of an undercut anchor, reference may be made to our earlier International patent application PCT/AU93/00055 (WO 93/16291). This anchor is designed to fit into an undercut of approximately conical shape which widens in cross-section in a direction towards the outer end of the hole. This form of undercut thus differs from other forms of conical undercut which only narrow in cross-section in a direction towards the outer end of the hole. One commonly used form of drill for producing an undercut which widens in a direction towards the outer end of the hole utilises a lever system which is manually actuated to progressively displace an array of diamond cutting elements in order to form a conical undercut in the base of the hole. Although this drill produces an effective undercut, it is extremely cumbersome to operate, particularly as the operator needs to actuate the lever system to displace the cutting elements whilst at the same time holding a power tool to which the drill is coupled for its rotational drive.

According to the present invention, there is provided a drill for forming an undercut in the base part of a hole drilled into masonry, said drill comprising a drive shaft, a cutter assembly coupled to a distal end of the drive shaft, said cutter assembly comprising a support structure and a plurality of cutters mounted on the support structure and arranged around a central axis which coincides with the axis of the drive shaft, each of said cutters being pivotally mounted on the support structure for pivotal movement between a retracted position in which the cutter assembly can move along the preformed hole into the base of the hole and a radially-expanded position in which the cutters form

a generally conical undercut in the base of the hole upon rotation of the drive shaft with the conical undercut widening in cross-section in a direction towards the outer end of the hole, and a cam system responsive to axial force applied to the drive shaft to cause pivotal displacement of the cutters from their retracted to expanded positions by pivotal movement of the cutters.

Advantageously, the pivotal mounting of each of the cutters is preferably releasable to permit removal and replacement of individual cutters.

Advantageously, the cutter assembly is mounted to the drive shaft by a coupling system which couples the cutter assembly rotationally to the drive shaft but which permits axial displacement between the cutter assembly and drive shaft. Preferably, the cam system comprises cam tracks formed at the outer end of the drive shaft, each cam track receiving a respective cutter such that the cutter is rotationally coupled to the drive shaft by engagement in the cam track and radially-outwards displacement of the cutter occurs by the action of the cam track by axial movement of the drive shaft towards the base of the hole when the cutter assembly is supported by the base of the hole. In a preferred embodiment, such movement of the drive shaft occurs against the resistance of compression spring means operatively interposed between the drive shaft and cutter assembly.

Advantageously, in a preferred embodiment the cam tracks may be of arcuate profile cut into the end portion of the drive shaft by a rotating cutter.

Embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings in which:-

Figure 1 is a perspective view of an undercutting drill in accordance with a preferred embodiment of the invention, radial cutters of the drill being shown in expanded positions for forming a conical undercut;

Figure 2 is a fragmentary view similar to Figure 1, but showing the cutters in contracted positions in which the drill can be inserted into and withdrawn from the hole

within the masonry.

Figure 3 is an axial section equivalent to Figure 1; and

Figure 4 is an exploded view showing the cutter assembly of the drill.

The drill in accordance with the preferred embodiment of the invention comprises a cutter assembly 2 formed by a support body 4 having a foot 6 which is adapted to rest against the base of a hole previously drilled into masonry by a conventional masonry drill. Outwardly of the foot 6, the body 4 is configured to provide a series of pivotal supports 8 each of which mounts a respective cutter 10 comprising a body 10a and a cutting insert 10b. The pivotal supports 8 are equi-angularly arranged around a central axis of the body 4 which coincides with the longitudinal axis of the drill. Each pivotal support 8 consists of a pair of parallel lugs 12 which are apertured to receive a pivot pin 14 which extends between the two lugs 12. The pivot pin 14 pivotally supports the cutter body 10a, the pin 14 passing through the base part of the cutter body 10a which is located between the two lugs 12. The cutting insert 10b carried by the cutter body 10a is preferably a carbide insert but alternatively may be a diamond insert. As shown, the support body 4 carries an array of three such cutters 10 distributed around the axis of the body 4, although other embodiments may consist of only two such cutters or four or more such cutter bodies evenly distributed around the axis of the body 4.

By means of the pivotal mounting of each cutter 10 on the support body 4, the array of cutters 10 can pivot between a configuration in which the cutters 10 are in an inner or retracted position (see Figure 2) in which the outer edges 18 of the cutting inserts 10b lie within an imaginary cylindrical surface of a diameter slightly less than the diameter of the hole previously drilled into the masonry, and an outer or expanded position (see Figure 1) in which the outer edges 18 of the cutting inserts 10b lie on an imaginary conical surface widening in a direction towards the outer end of the hole, this conical surface corresponding to the conical undercut which the drill produces. The movement of the cutters 10 from their retracted to their expanded positions is obtained by interaction between the cutter bodies 10a with camming surfaces at the outer end portion of a drive shaft 20 which forms the main body of the drill and to which the cutter

assembly 2 is releasably attached, as will now be described.

The main body or drive shaft 20 of the drill is of tubular form and is configured at its proximate end for insertion into the tool holder or chuck of a suitable power drill such as a hammer drill. The interior of the drive shaft 20 has a large diameter bore 22 which is threaded at its proximate end portion to receive a threaded plug 24. The large diameter bore 22 extends along a substantial part of the length of the drive shaft 20 and towards the outer end of the drive shaft is inwardly stepped to form a smaller diameter bore 26 which extends to the outer end of the drive shaft 20. The cutter assembly 2 is attached to the drive shaft 20 by means of a set screw 28 extending from the interior of the hollow drive shaft through the reduced diameter bore 26 at the outer end portion of the drive shaft 20, with the outer end of the set screw being screwed into a threaded bore 30 in the centre of the support body 4. The head 28a of the set screw 28 lies within the large diameter bore 26 of the drive shaft 20 and the shank of the set screw 28 is of such a length as to permit axial displacement of the cutter assembly 2 relative to the drive shaft 20 through a restricted distance between an outer position in which the head 28a of the set screw 28 is in abutment with the step 32 formed at the end of the larger diameter bore 22 and an inner position in which the support body 4 of the cutter assembly 2 abuts against an outer end edge of the drive shaft 20. A compression spring 36 is mounted within the larger diameter bore 22 of the drive shaft 20 between the plug 24 and the head 28a of the set screw in order to bias the set screw 28 and hence the cutter assembly 2 into the outer position, the spring 36 acting against the head 28a via a shaped spacer washer 38.

The outer end portion of the drive shaft 20 is shaped with a series of angularly-spaced cam tracks 40 each of which cooperates with a respective one of the cutter bodies 10a, each track 40 being of a width such that the associated cutter body 10a is received and located between the opposite side walls 40a of the cam track 40. In this manner the cutter assembly 2 is rotationally coupled to the drive shaft 20. In the "at rest" condition of the drill, the cutter assembly 2 is biased into its axially outer position relative to the drive shaft by the action of the compression spring 36 and in this condition the cutters

10 are in their inner or retracted positions in which the drill can be inserted into a hole previously drilled into masonry so that the foot 6 of the support body 4 rests against the base of the hole. Actuation of the associated power tool to drive the drill in conjunction with axial loading applied to the power tool and hence the drive shaft 20 by the operator will cause the drive shaft 20 to move downwardly along the hole further towards the cutter assembly 2 whereby the cam tracks 40 of the drive shaft 20 will progressively pivot the cutters 10 outwardly to progressively form the conical undercut. The undercut is completed when the end of the drive shaft 20 "bottoms" against the support body 4 and which corresponds to the outer or expanded position of the cutters 10.

When the undercut is complete, the power tool is switched off and the axial loading applied to the drill is relaxed whereby under the force of the compression spring 36 the drive shaft 20 will withdraw relative to the support body 4 into its "at rest" configuration. In the "at rest" configuration, the array of cutters 10 is surrounded by a ring-shaped retainer clip 44 mounted in a groove 46 at the end portion of the drive shaft 20. The retainer clip 44 contacts the outer surface of the cutter bodies 10a and retains the bodies in their retracted positions (see Figure 2). During cutting of the undercut as the drive shaft 20 is pushed towards the cutter assembly 2, the retainer clip 44 carried by the drive shaft 20 will move along the array of cutter bodies 10a towards the base of the cutter bodies 10a so as to permit the outwards pivotal movement induced by the engagement between the cutter bodies 10a and cam tracks 40, the shaping of the cutter bodies 10a in the zone in which they are contacted by the retainer clip 44 being such as to permit the required outwards pivotal movement (see Figure 1). Conversely, when the axial loading on the drive shaft 20 is released after the undercut has been formed, the return of the drive shaft 20 to its "at rest" position under the action of the compression spring 36 will draw the retainer clip 44 along the cutter bodies 10a to thereby pivot the cutter bodies 10a back into their retracted positions whereby to permit withdrawal of the drill from the hole.

The cutter inserts 10b of the cutters 10 will be subject to wear over a period of time, but the construction of the drill is such that the cutters 10 can readily be replaced.

To replace the cutters 10, the plug 24 and compression spring 36 are removed from the drive shaft 20 so that the set screw 28 can be unscrewed from within the interior of the drive shaft 20 to release the cutter assembly 2. When the cutter assembly 2 is released from the drive shaft 20, the pivot pins 14 are removed in order to permit detachment of the individual cutters 10 and replacement by new cutters. To facilitate ease of removal and replacement of the pivot pins 14, the pivot pins 14 are preferably in the form of roll pins formed from spring steel strip. This form of pivot pin will securely retain the cutters to the support body 4, but can also readily be inserted and withdrawn.

Although the cam tracks 40 can be of any required shape, as illustrated they are of arcuate profile. This is advantageous as it enables the tracks to be cut into the end of the drive shaft 20 by a rotary cutter which is a simpler, and less expensive technique than machining, which would be required to produce a cam track in the form of, for example, a rectilinear ramp.

Although it is preferred to use carbide cutting inserts which permit the use of a hammer drill, alternatively the cutting inserts may be diamond inserts. When diamond inserts are used, only a rotary action, in contrast to a combined rotary and hammer action, can be applied to the drill.

When a hammering action is applied when carbide inserts are used, the cooperation between the cam tracks 40 and cutter bodies 10a will transform the axial hammer forces applied to the drive shaft 20 into generally radially-outward forces applied to the cutters resulting in substantial improvement in cutting efficiency. Under the applied hammering forces the carbide inserts will operate more effectively when, as illustrated, their radially outer edges 18 are flat rather than pointed edges.

Advantageously, the foot 6 of the support body 4 and which rests against the base of the hole is of a reduced diameter in relation to that of the hole. This leads to reduced friction between the foot 6 and the base of the hole whereby more of the driving torque can be translated into useful cutting work. The foot 6 is also formed with a series of

recesses or cut only 50 around its periphery to facilitate removal of dust and debris formed during cutting. Dust and debris removal may alternatively, or in addition, be facilitated by the incorporation of a system of spiral grooves along the outer surface of the body of the drive shaft.

The embodiment has been described by way of example only and modifications are possible within the scope of the invention.

CLAIMS:

1. A drill for forming an undercut in the base part of a hole drilled into masonry, said drill comprising a drive shaft, a cutter assembly coupled to a distal end of the drive shaft, said cutter assembly comprising a support structure and a plurality of cutters mounted on the support structure and arranged around a central axis which coincides with the axis of the drive shaft, each of said cutters being pivotally mounted on the support structure for pivotal movement between a retracted position in which the cutter assembly can move along the preformed hole into the base of the hole and a radially-expanded position in which the cutters form a generally conical undercut in the base of the hole upon rotation of the drive shaft with the conical undercut widening in cross-section in a direction towards the outer end of the hole, and a cam system responsive to axial force applied to the drive shaft to cause pivotal displacement of the cutters from their retracted to expanded positions by pivotal movement of the cutters.

2. A drill according to claim 1, wherein the cutter assembly is mounted to the drive shaft by a coupling system which couples the cutter assembly rotationally to the drive shaft but which permits axial displacement between the cutter assembly and drive shaft.

3. A drill according to claim 2, wherein the cam system comprises cam tracks formed at the outer end of the drive shaft, each cam track receiving a respective cutter such that the cutter is rotationally coupled to the drive shaft by engagement in the cam track, and radially-outwards displacement of the cutter occurs by the action of the cam track by axial inwards movement of the drive shaft towards the base of the hole by axial force applied to the drive shaft when the cutter assembly is supported by the base of the hole.

4. A drill according to claim 3, further comprising spring means operatively interposed between the drive shaft and cutter assembly to act in opposition to the axial inwards movement of the drive shaft towards the base of the hole, said spring means acting to return the drive shaft to an axial outer position when the axial force is removed.

5. A drill according to claim 4, comprising means for effecting radially inwards displacement of the cutters in response to return movement of the drive shaft.

6. A drill according to claim 5, wherein the means for effecting radially inwards displacement of the cutters comprises a ring carried by the drive shaft, said ring surrounding the array of cutters and contacting radially outer surfaces of the cutters at least when the drive shaft is adjacent its axially outer position.

7. A drill according to any one of claims 3 to 6, wherein the cam tracks are of arcuate profile cut into the end portion of the drive shaft by a rotating cutter.

8. A drill according to any one of claims 1 to 7, wherein the pivotal mounting of each of the cutters is releasable from the support structure to permit removal and replacement of individual cutters.

9. A drill according to any one of claims 1 to 8, wherein the cutters comprise carbide inserts having flat radially-outer edges.

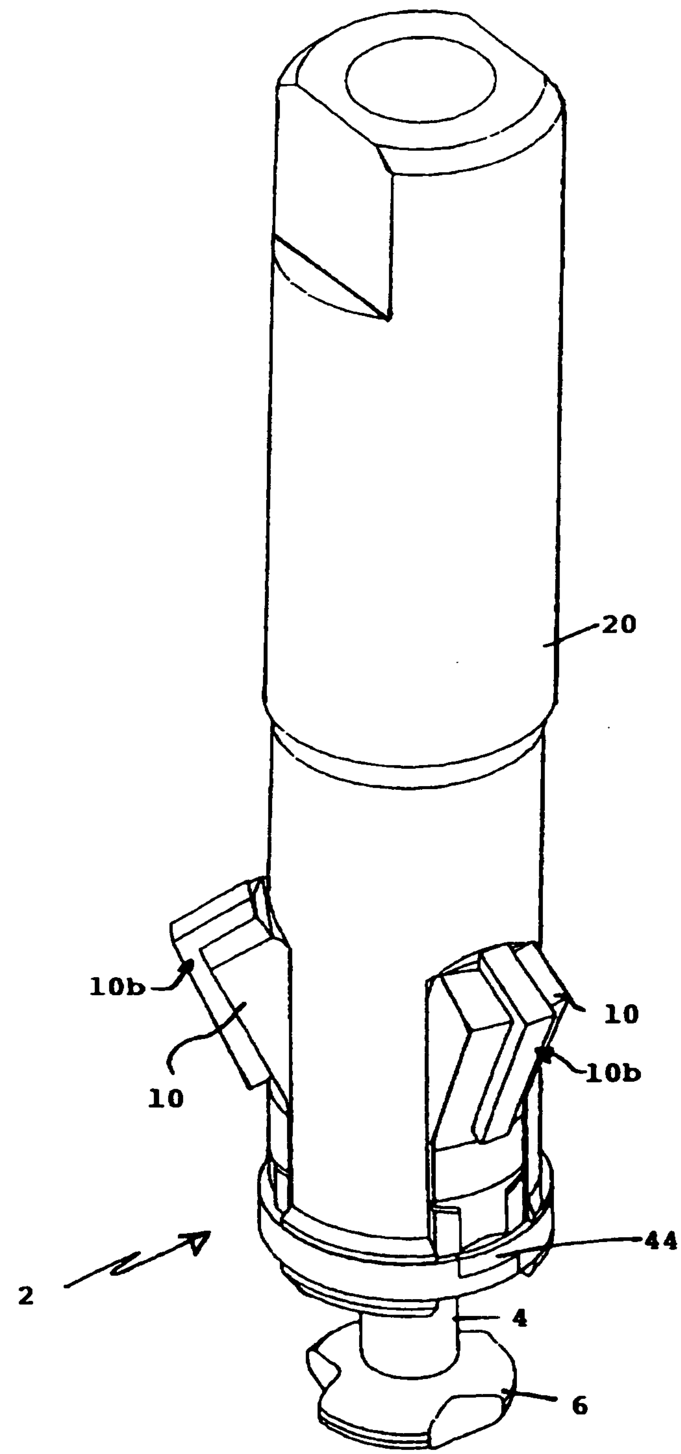

FIG. 1

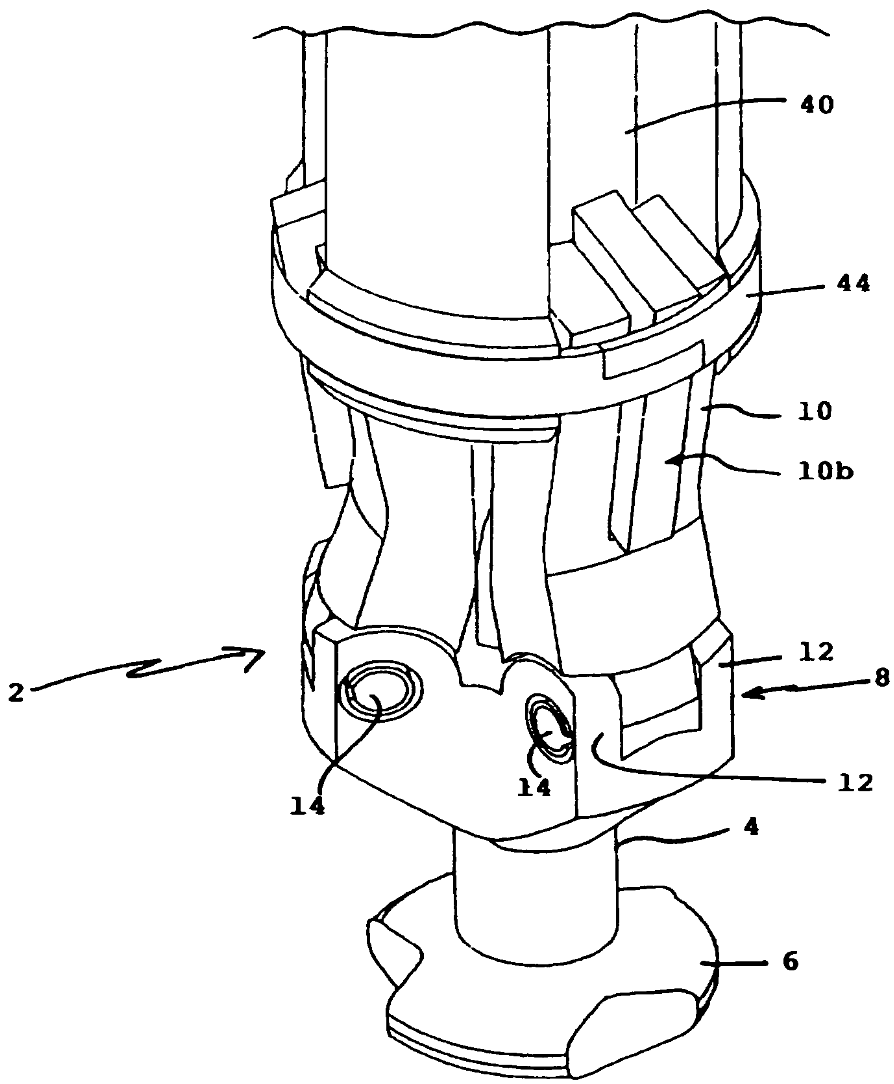

FIG. 2

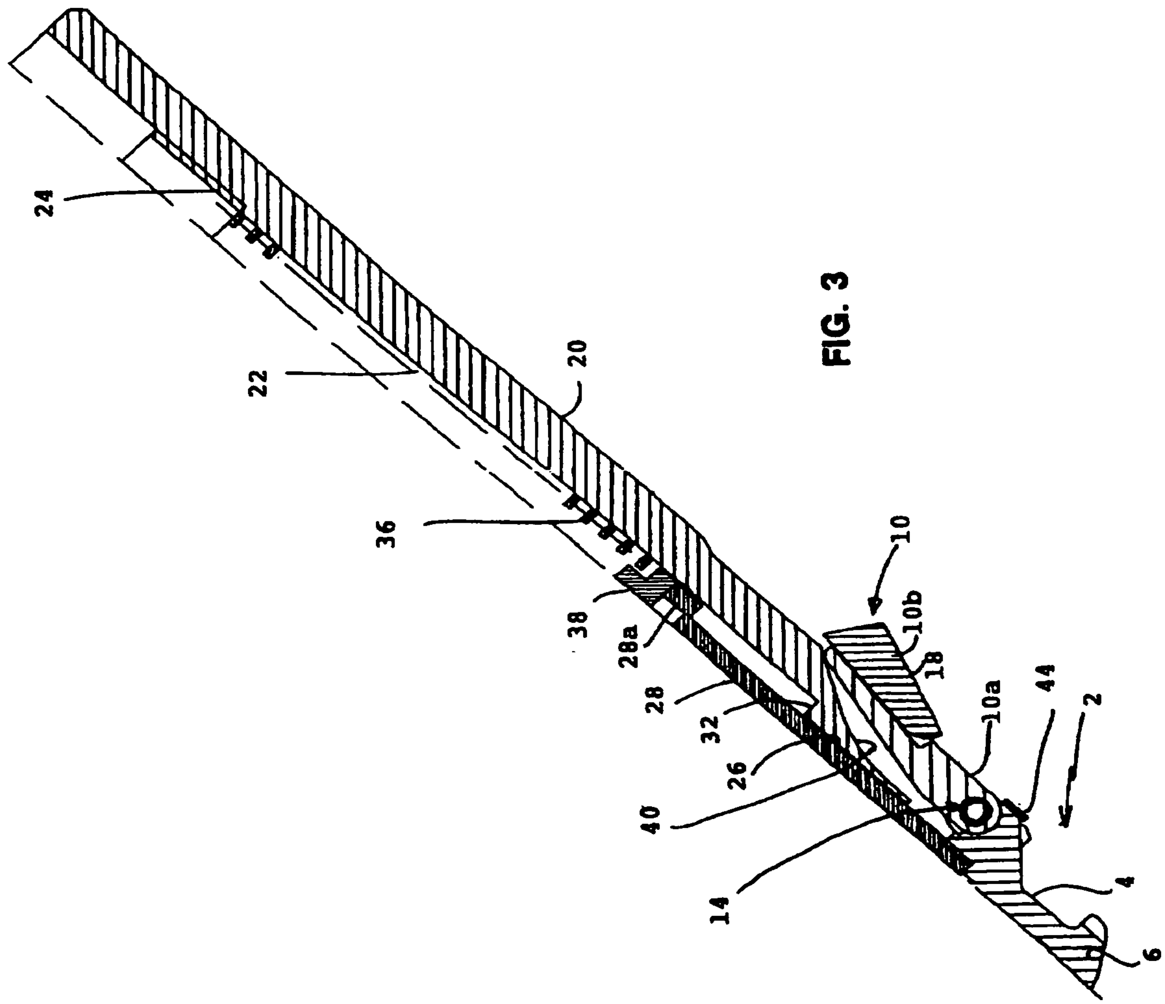

FIG. 3

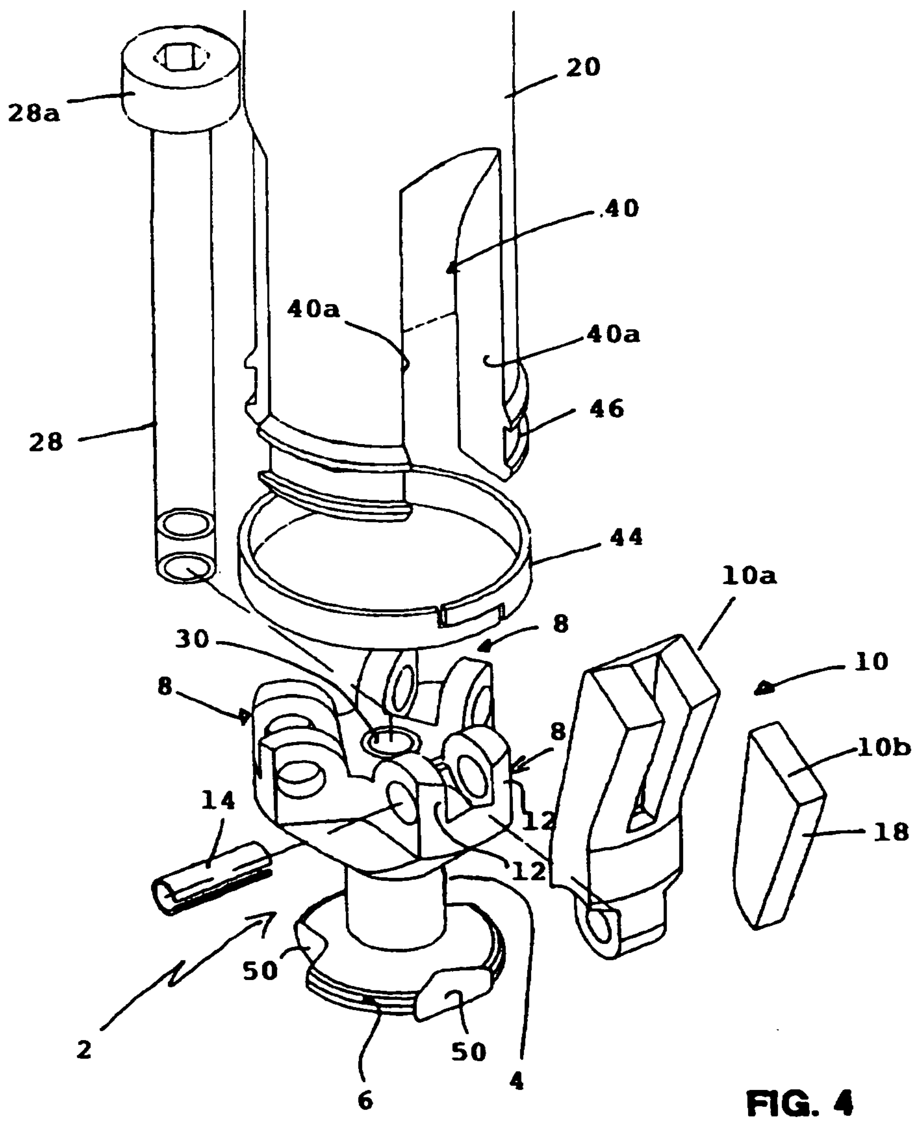

FIG. 4

INTERNATIONAL SEARCH REPORT

International Application No.
PCT/AU 96/00738

A. CLASSIFICATION OF SUBJECT MATTER

Int Cl^6: B23B 29/034, B28D 1/14

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC B23B 29/034, B28D 1/14

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	EP 408379 A (PAYNE) 16 January 1991	
X	line 19, col. 4- line 32, col 6 and Fig.s 1-4	1
A	whole document	2-9
	DE 3909481 A (ADOLF WURTH GmbH & CO KG) 27 September 1990	
X	Fig.s 4 & 6	1
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A	AU 34859/93 A (RAMSET FASTENERS AUSTRALIA PTY. LTD.) 19 August 1993 whole document	1-9

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No.
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		EP	370204	JP	2184409		
AU	44460/96	EP	729802	JP	8229931		
AU	34859/93	EP	626041	WO	9316291		
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